Beach Nourishment – Design Approaches
South Carolina Experience

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Debidue Beach

1970s Conventional Wisdom – Beach Erosion Control

- Shoreline armoring is property owners' favored solution to coastal erosion
- Beach Nourishment is expensive
- Beach Nourishment only lasts 3 years
- Only Large Federal Projects are feasible
- Coastal Engineers don't understand the coast
- Coastal Geologists frame of reference is glacial time periods
- Nourishment is bad for the environment
- Numerous "low cost solutions" tried

Flash Forward – Myrtle Beach 2004

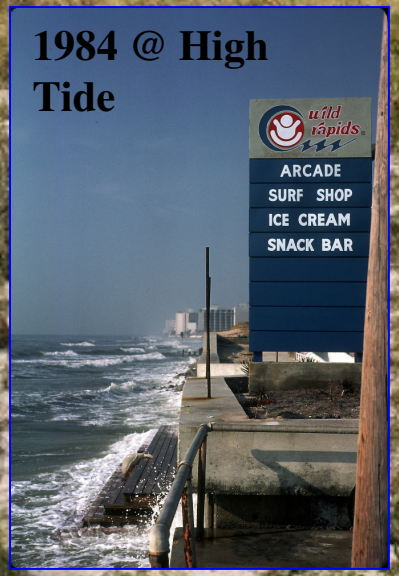
1984-2004 - Nourishment Projects ('86, '89 & '97)

Nine (9) Miles - 3.5 million Cubic Yards

Cost ~ $20 million, or ~$2 million per mile

= ~$20 per foot of beach per year!

1980 @ Low Tide



1984 @ High Tide

Presentation Outline

Topics Covered

- Define Beach Nourishment
- General Design Approach
- Successful Programs
- Future Needs

Via Cutterhead Suction Dredge

Information Sources:

1) *Beach Nourishment & Protection, NRC 1995*
2) *Beach Nourishment Theory & Practice, Dean 2002*
3) *Manual on Artificial Beach Nourishment, Delft Hydraulics 1987*
4) *Coastal Engineering Manual, USACE 1995-2002*
5) *Conserving SC Beaches Through the 1990s, Kana 1990*

Beach Nourishment

Beach Nourishment –

The addition of sand to a beach from an external source for purposes of advancing the shoreline seaward.

"Beach nourishment …is…the only engineered shore protection alternative that directly addresses the problem of a sand budget deficit." NRC, 1995, pg 1.

Methods of Construction –

Hydraulic Dredge – hopper dredges & cutterhead-suction dredges

Truck Hauling from inland stockpiles

Transfer by barge or other conveyance

Related Activities - That Locally Increase The Sand Budget of a Site

Inlet Relocation – Forced Shoal Bypassing of Ebb Tidal Delta Deposits

Channel Realignment – To address localized erosion adjacent to Inlets

Borrowing & Transfer - From Renewable Accretion Zones To Erosion Zones

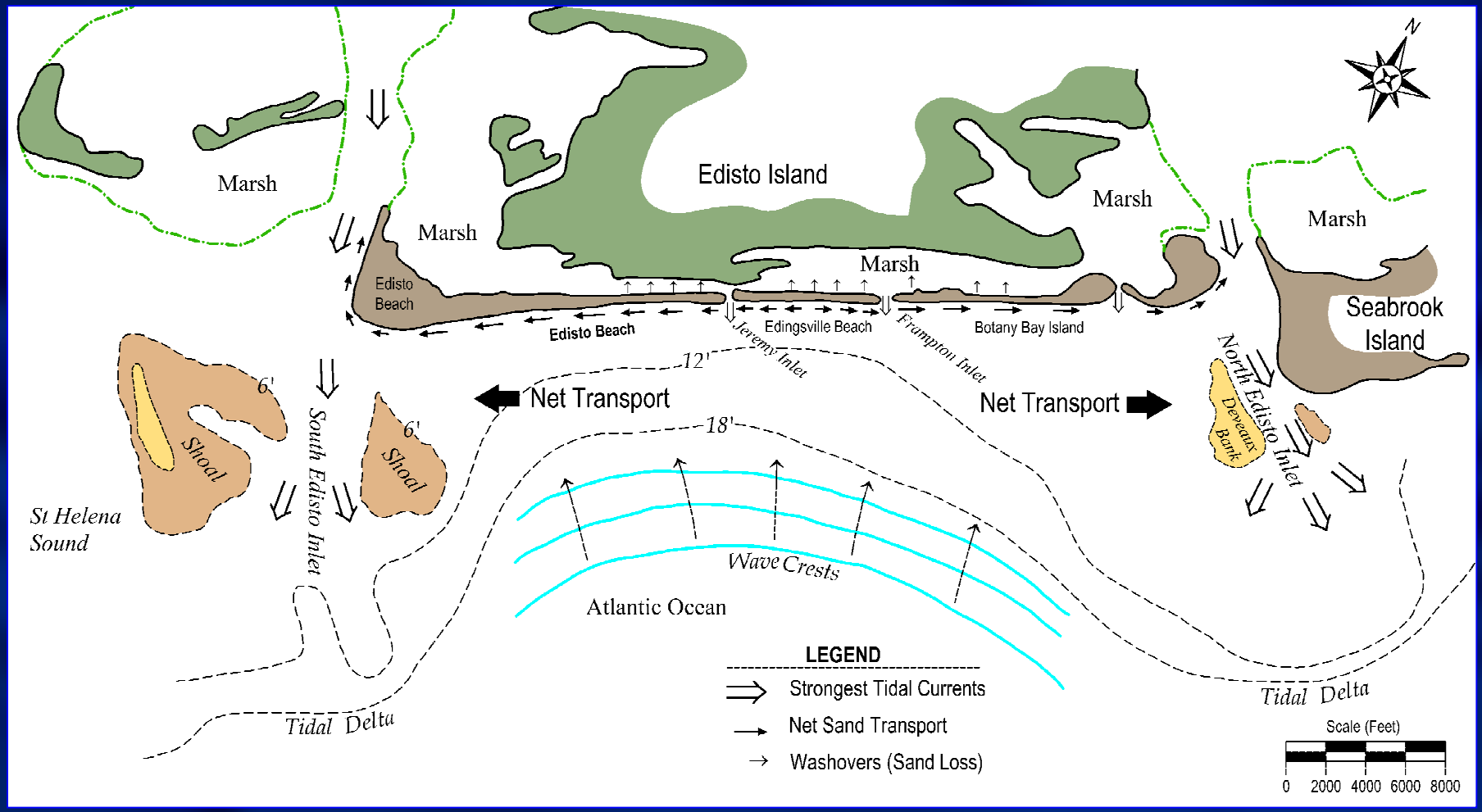
General Approach For Beach Nourishment - CSE

1) Determine Causes and Rates of Erosion
2) Locate the Nearest Source of Sand
3) Move it the Cheapest Way
4) Cover Your Tracks
5) Monitor The Results

1) Determine Causes & Rates of Erosion

- ✓Conceptual Geomorphic Models of Sand Transport & Controlling Processes
- ✓Define Littoral Cells
- ✓Measure Erosion Rates to Closure Depth
- ✓Prepare Sediment Budgets

Goal: Identify the Primary Erosion Cause(s) For The Site

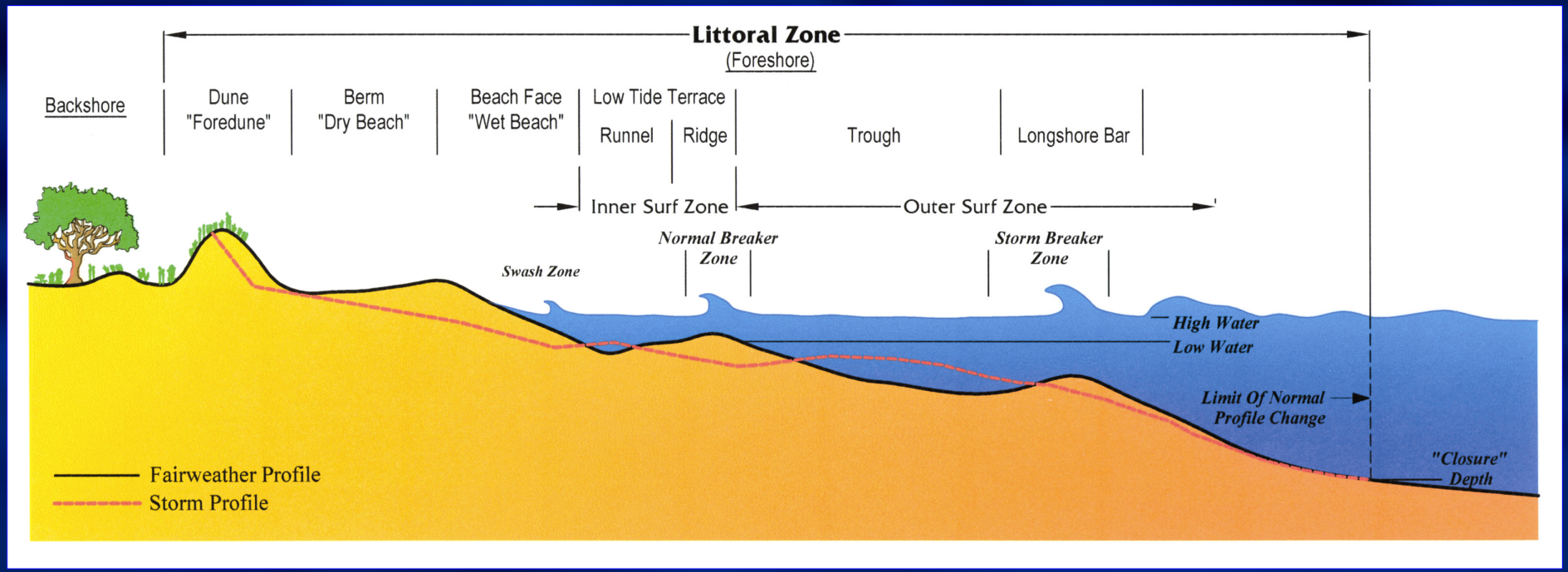


1) Determine Causes & Rates of Erosion

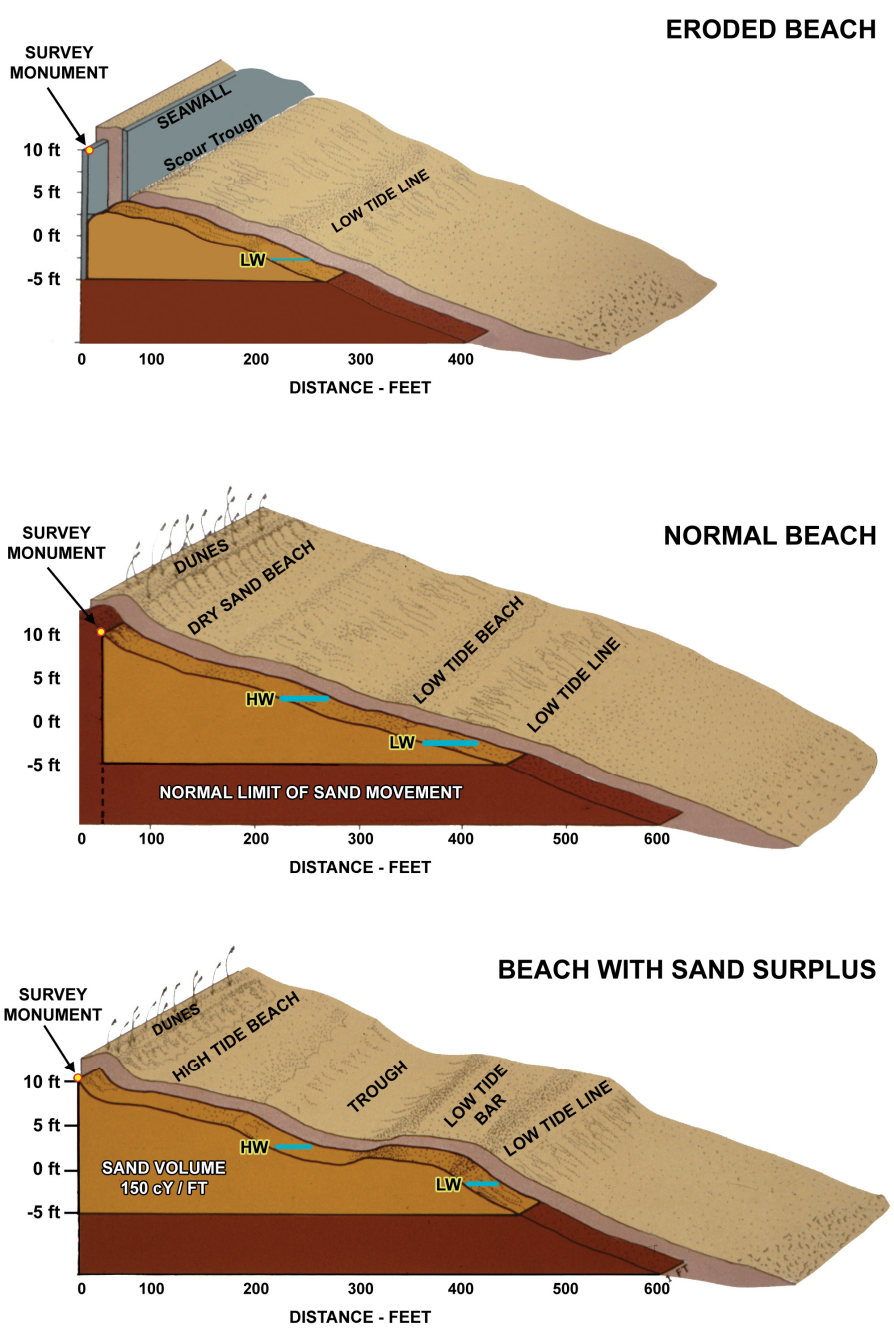
"Most developed shorelines are changing by <u>less than 3 ft per year</u> at decadal to century time scales." *Source: Dolan et al (1990).*

Photo by Milan Kana

Why? Because most of the Coast is in Dynamic Equilibrium -



1) Determine Causes & Rates of Erosion



Nourishment Needs – *function of* Sand Deficit & Average Annual Volume Losses

Typical Ranges:

Deficit - 25 to 150 cy/ft

Annual – 1 to 10 cy/ft/yr

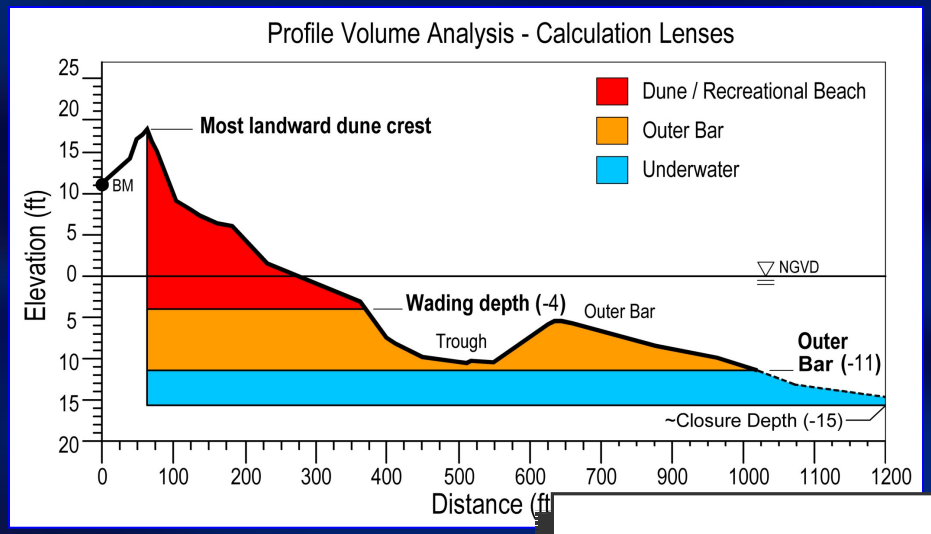
Nourishment Costs – *function of* Sand Availability, Sand Quality, and Construction Method

Typical Range:

$1 to $10 per cubic yard

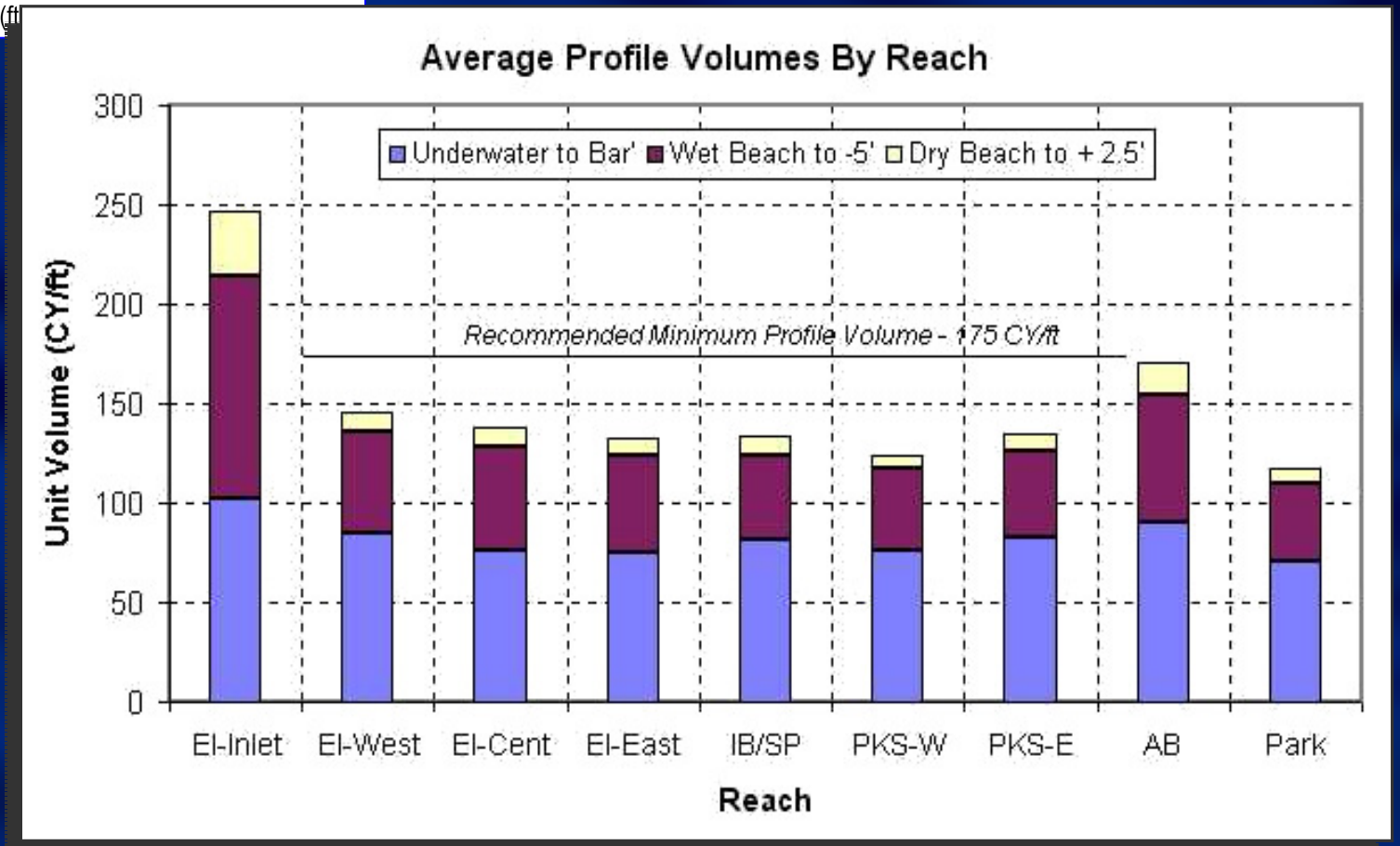
Source: Kana 1990

1) Determine Sand Deficit

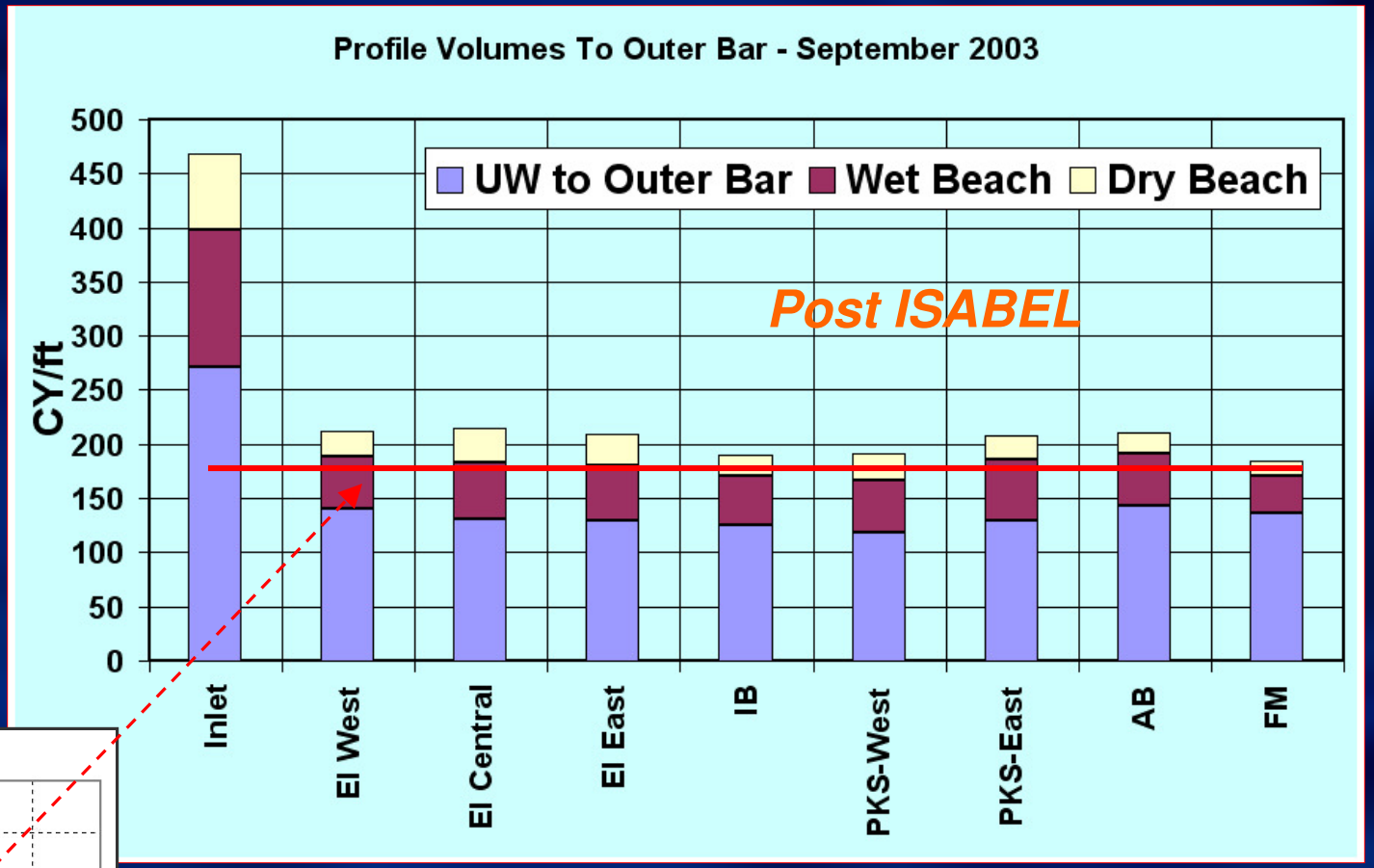


Goal

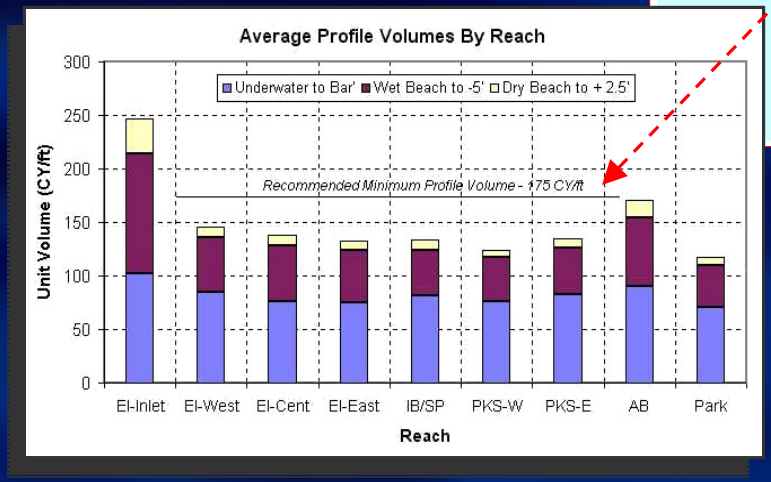
- **Profile Volumes to Accommodate the Normal Range of Beach Changes**



1) Establish Deficit, Restore Beach & 5) Monitor Performance

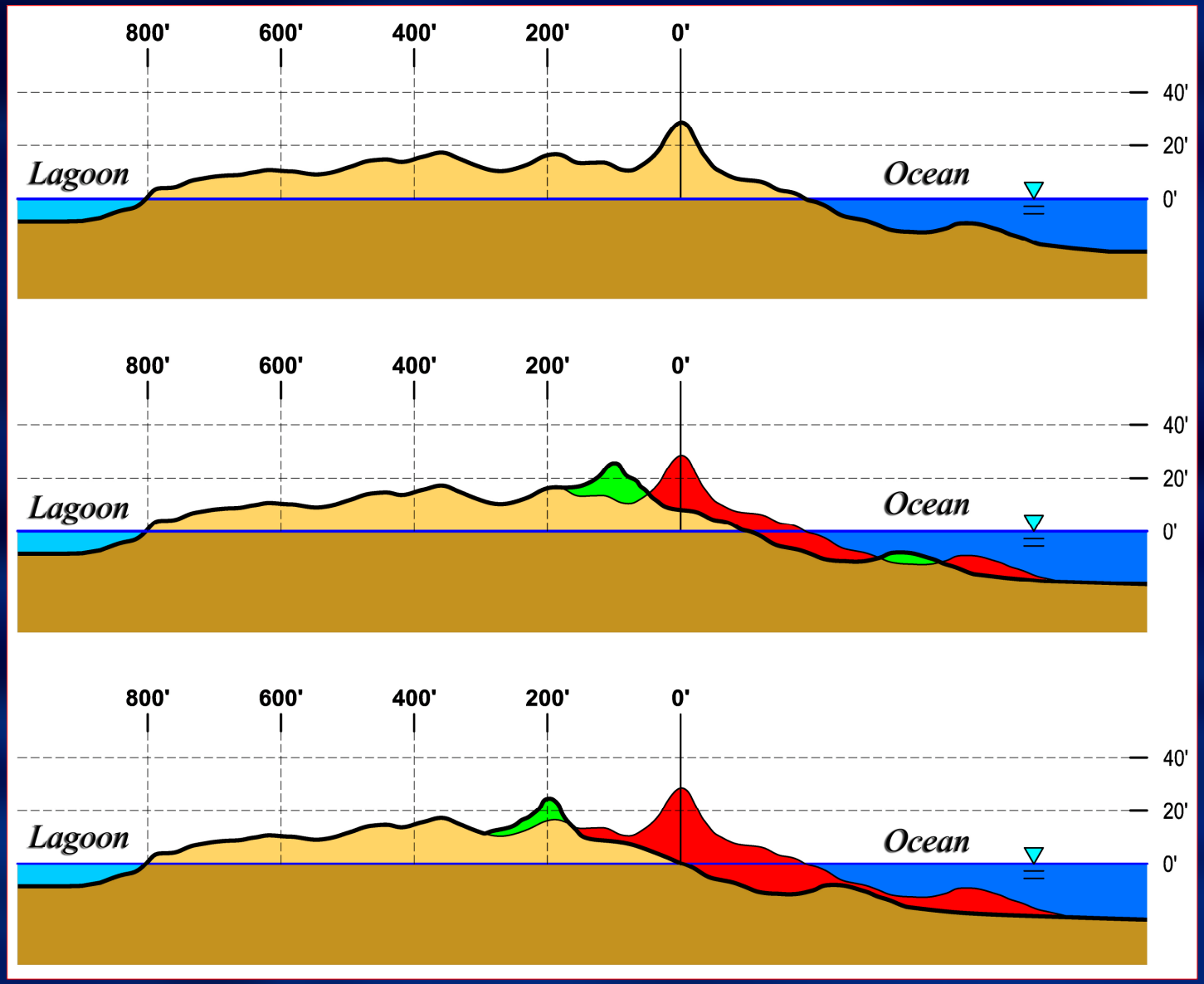


Pre Nourishment



Criteria Should be a Volume Measure as well as qualitative measures (e.g. dry beach width).

Beach Ridge Barrier Island – 100 Yrs Erosion



@ 2 ft/yr

Volume Erosion Rate:

~2 CY/ft/yr

50-Yr Loss:

~100 CY/ft

100-Yr Loss:

~200 CY/ft

Washover Barrier Island

Edingsville Beach SC

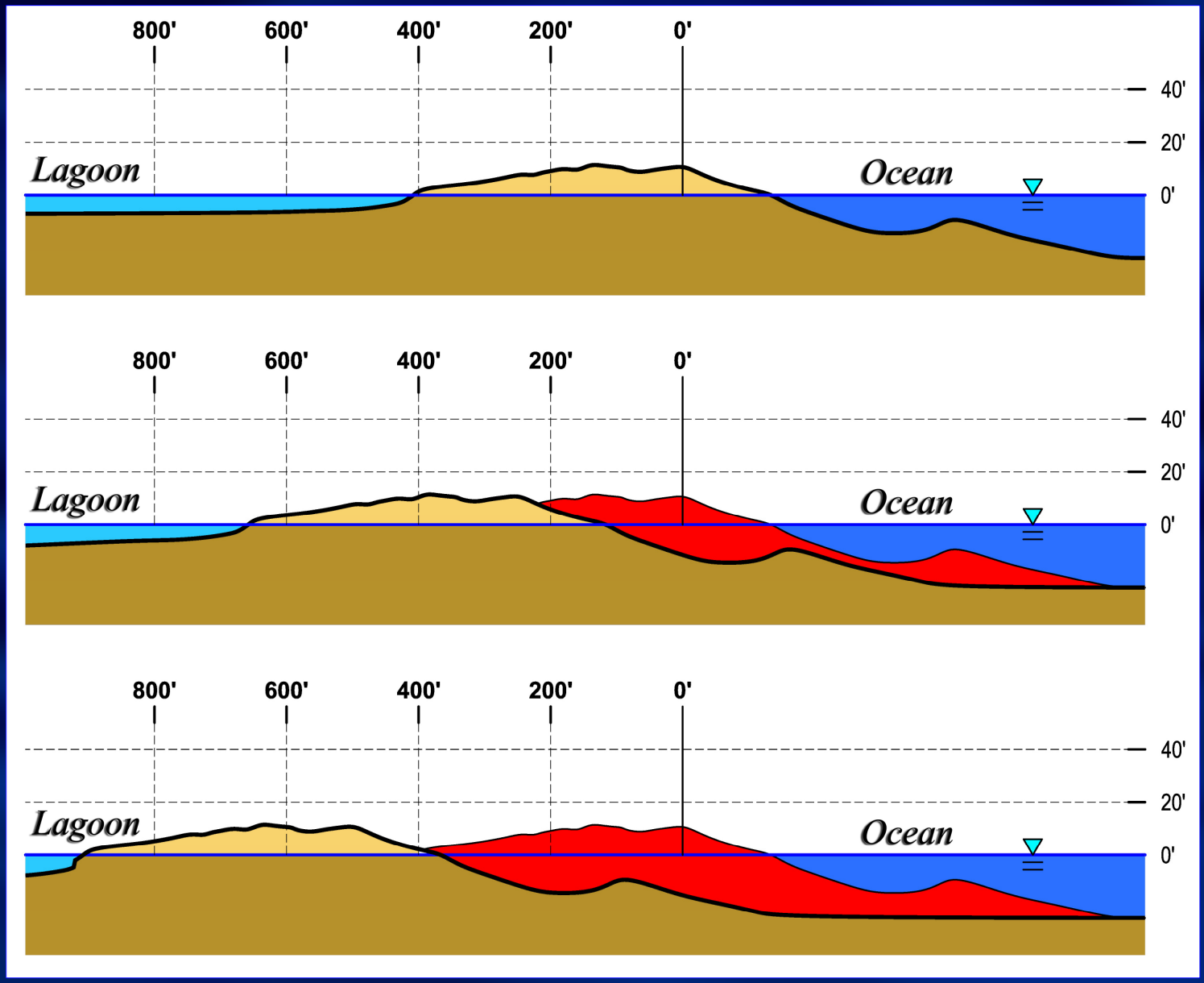
"Planter's" Cottages
Abandoned by 1893

Century Erosion Rates:

10-15 ft/yr

Washover Barrier Island – 100 Years Erosion

"The Beaches Are Moving!" *Kaufman & Pilkey, 1979*



@ 5 ft/yr

Volume Erosion Rate:

~5 CY/ft/yr

50-Yr Loss:

~250 CY/ft

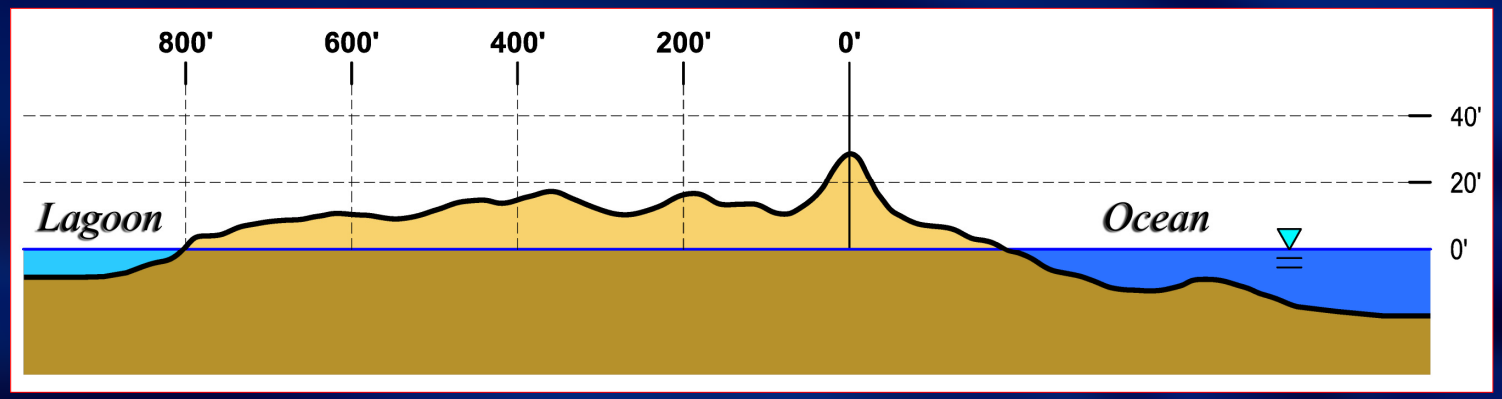
100-Yr Loss:

~500 CY/ft

Barrier Island Profiles

Which Section Do You See When You Think About Barrier Islands?

Beach Ridge Barrier Island

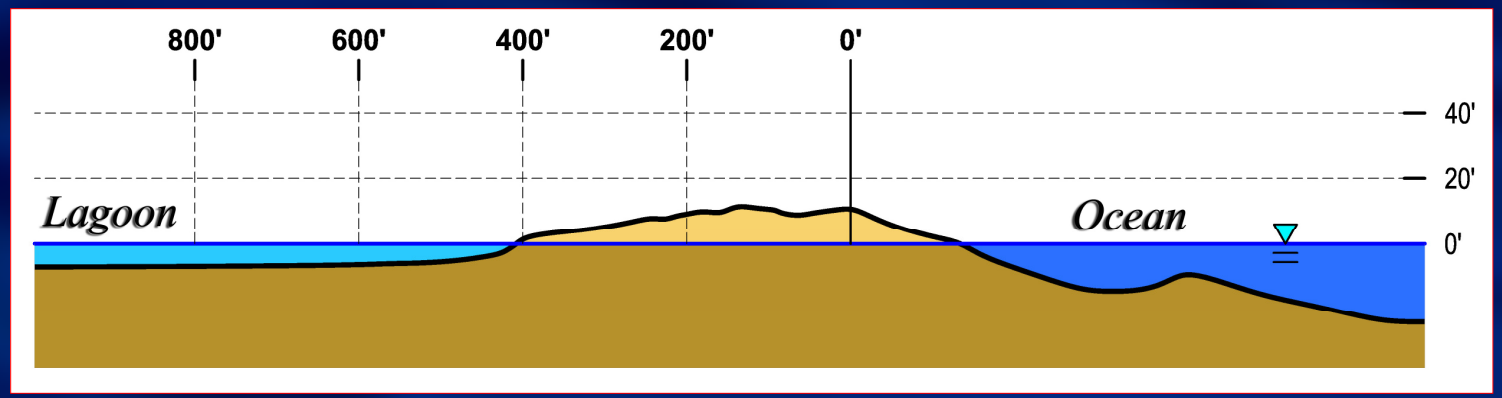


Present Cost to Maintain Beach:

@ 2 CY/ft/yr Erosion Rate =

~$10-16/ft/yr

Washover Barrier Island



@ 10 CY/ft/yr Erosion Rate =

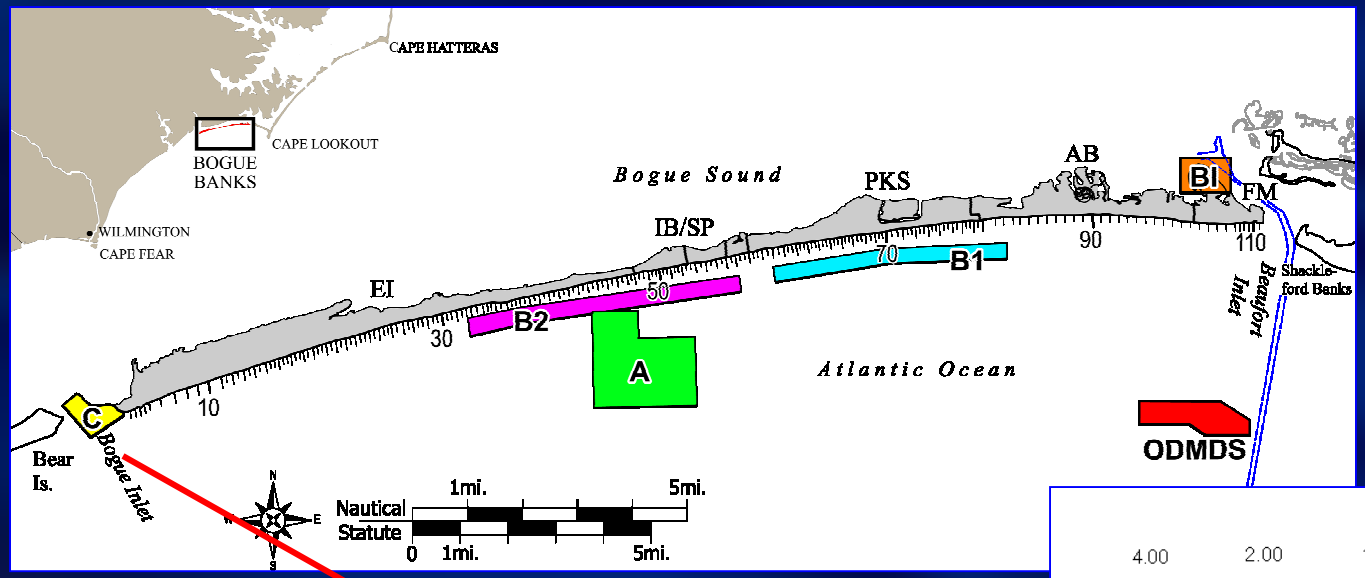
~$50-90/ft/yr

2) Find The Nearest Source of (Quality!) Sand

Location and Confirmation via Geophysical & Geotechnical Studies

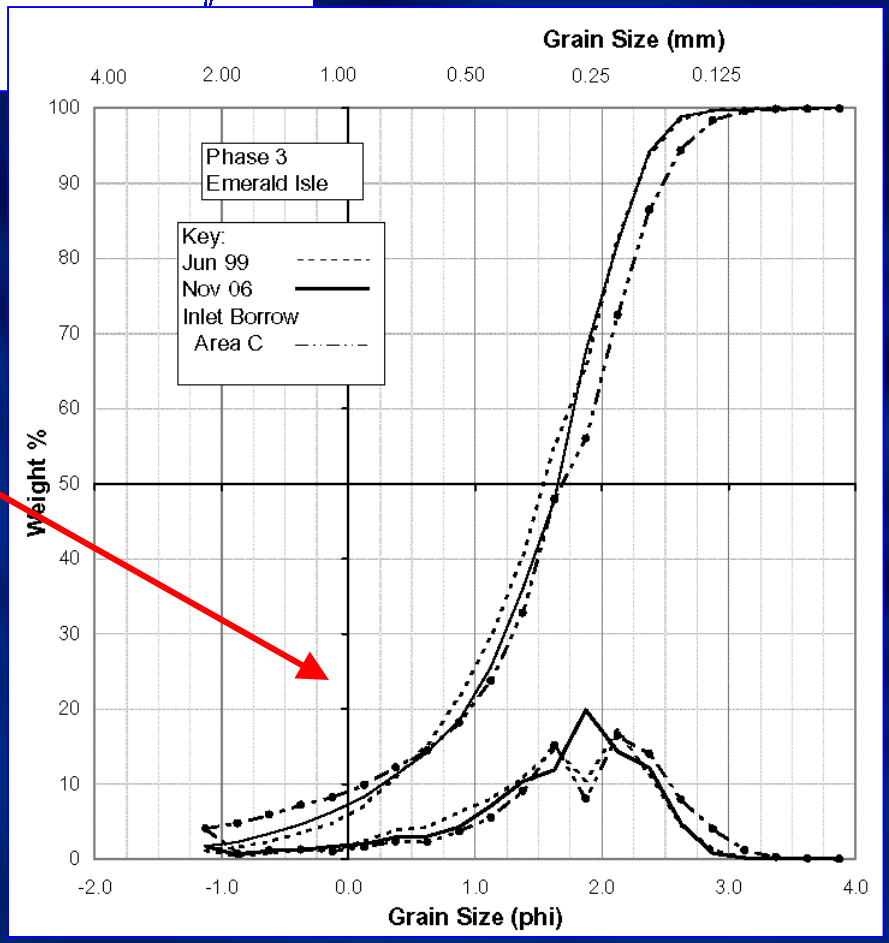
- ***Beach Compatible*** – Meaning Similar Grain Size Distribution As The Native Beach. Why?
- Feasible Area For Dredging or Truck route
- Relatively Small Transport Distance
- Outside the Active Littoral Zone
  - Beyond Depth of Closure
  - If Part of an Ebb Tidal Delta – Represents a Small % of Delta Volume & Will Not Exacerbate Erosion Nearby
- Low % Silts & Clays (Target <5%)
- Low % of Gravel (Target <5% over ambient)

2) Find Nearest Source of Sand

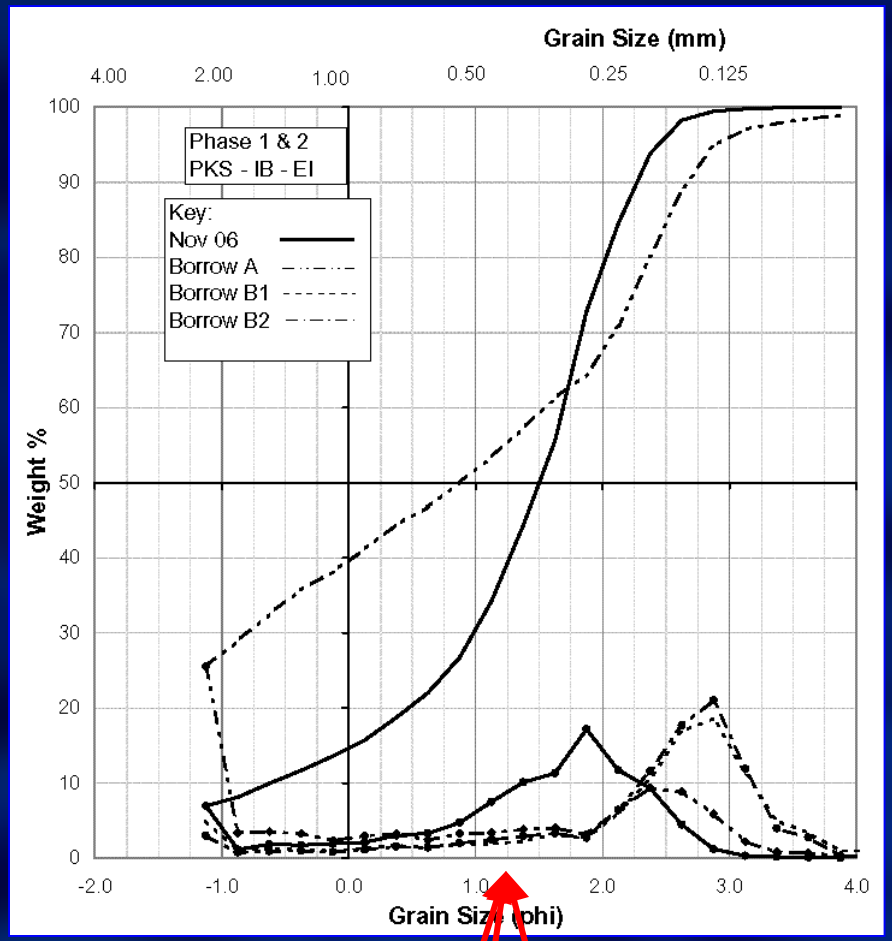


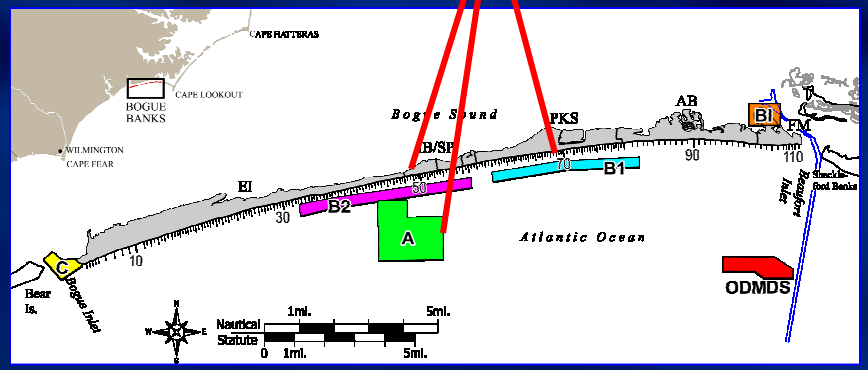
Example – Ideal Source

w/respect to Grain Size Distribution (GSD)

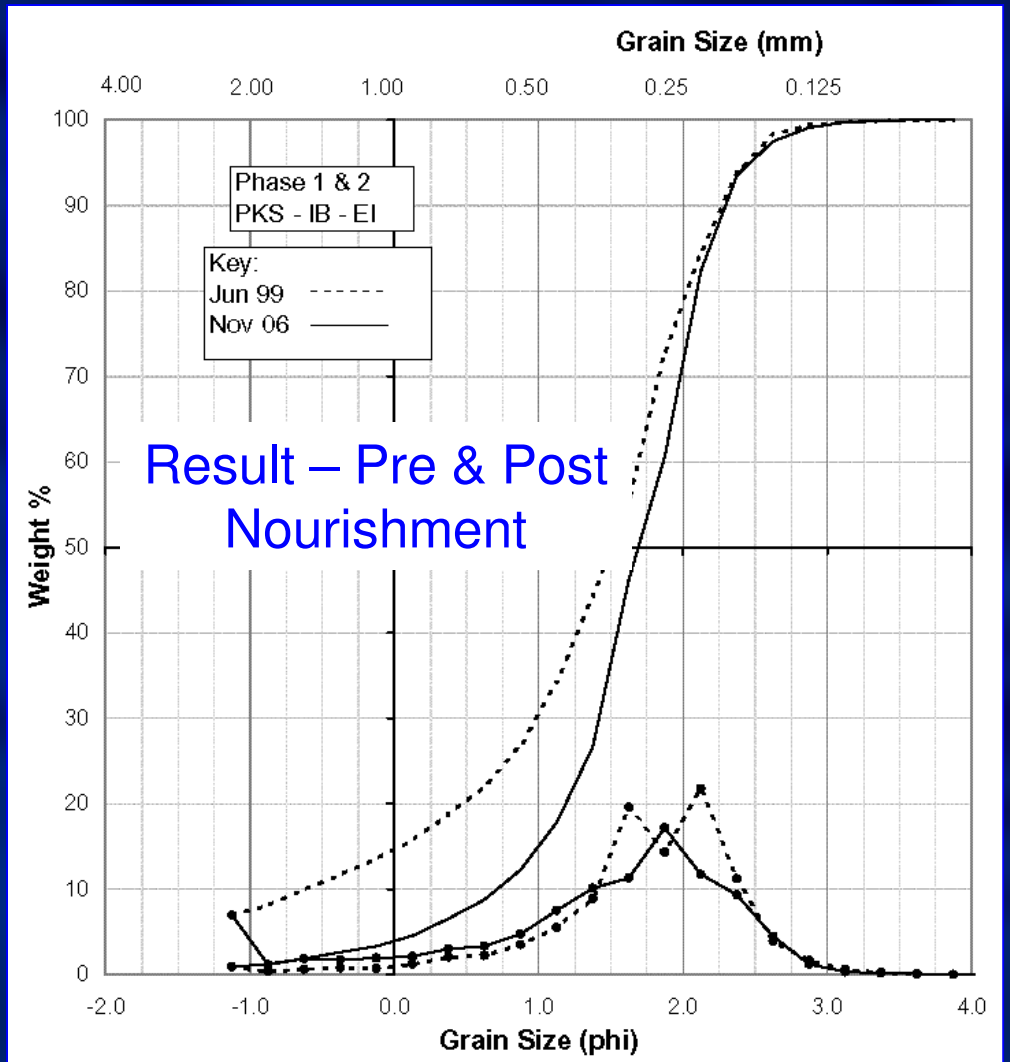


2) Find Nearest Source of Sand

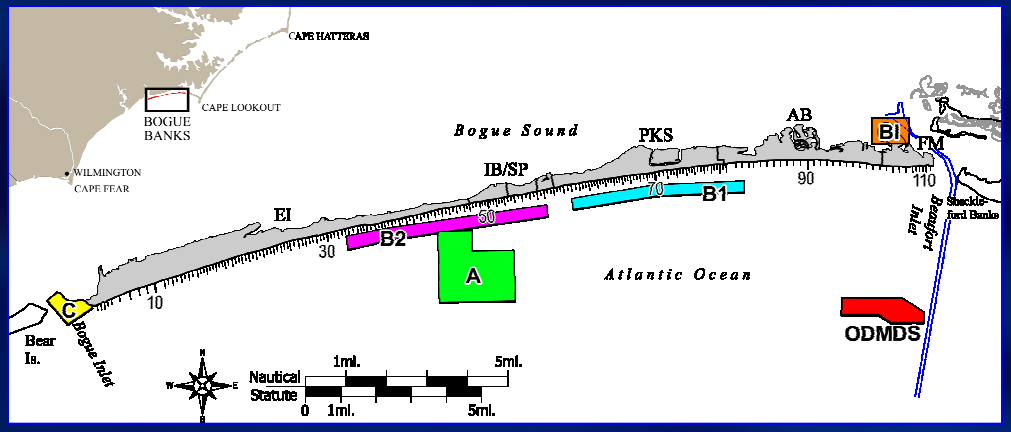




Example: Mixing Dissimilar Sources

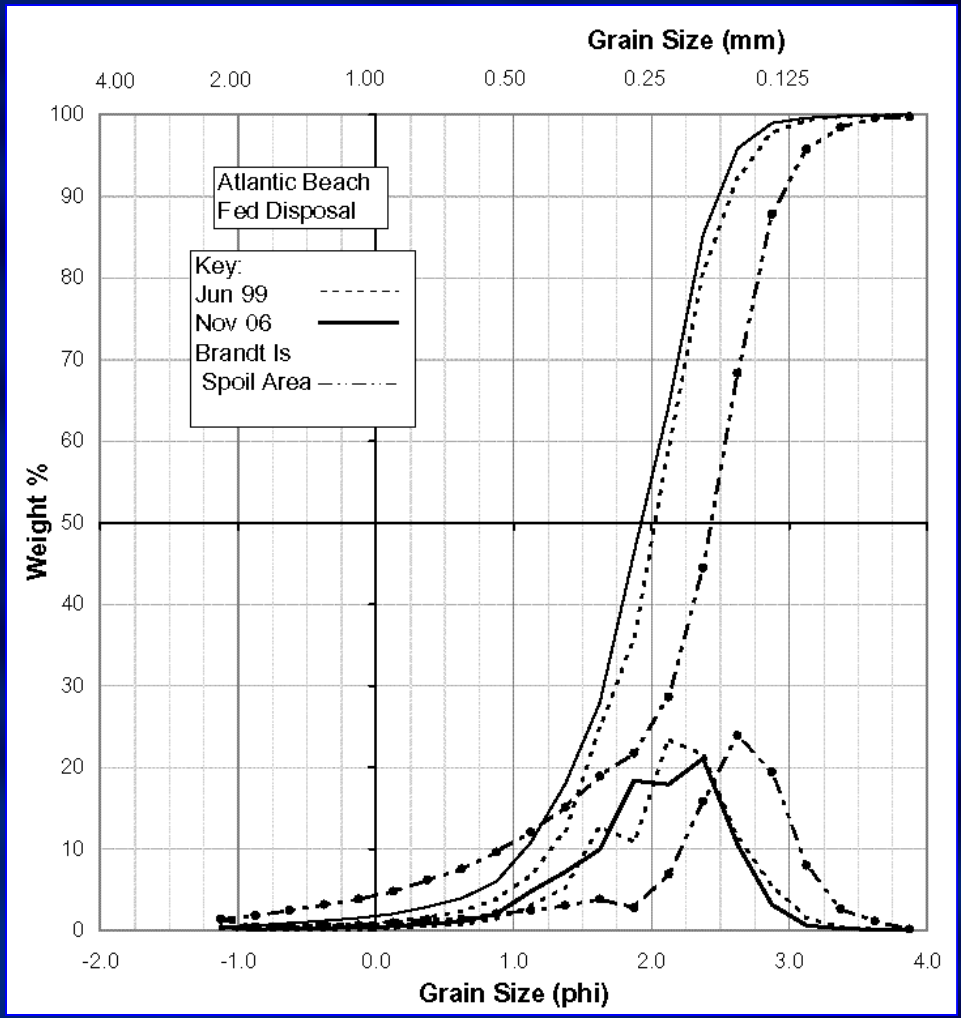


2) Find Nearest Source of Sand



Example: Using Finer Material

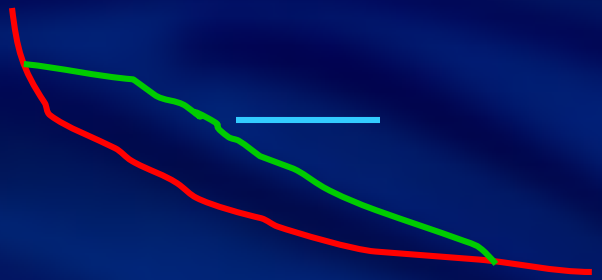
What are The Implications?



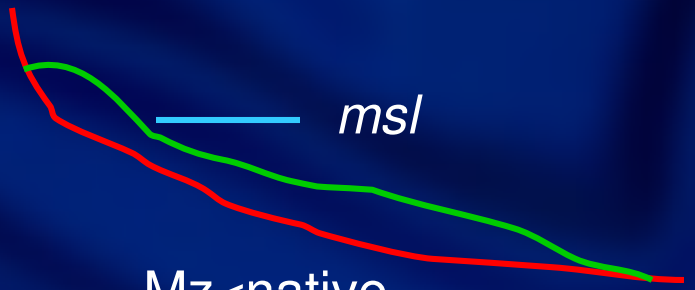
2) Find Nearest Source of Sand

Implications for Profile Development – Dry Beach Width Varies!

Mz>native

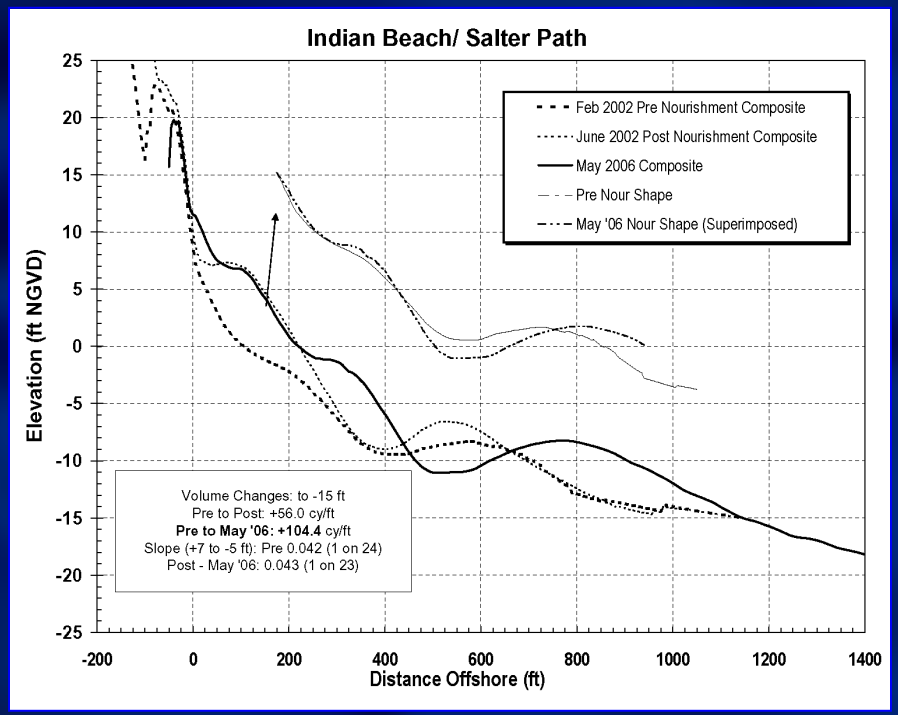


Mz~=native

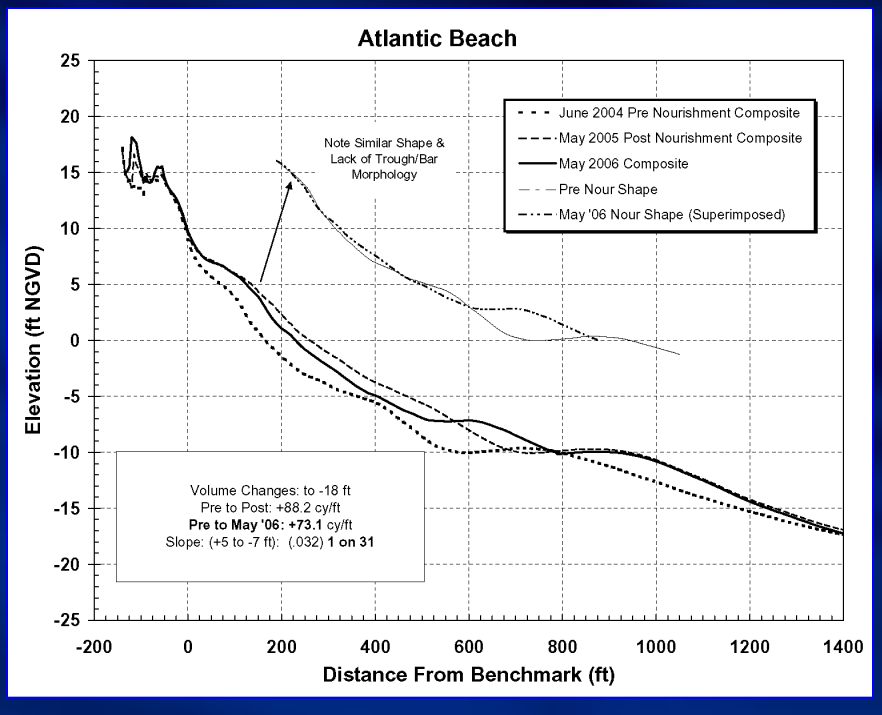


Mz<native

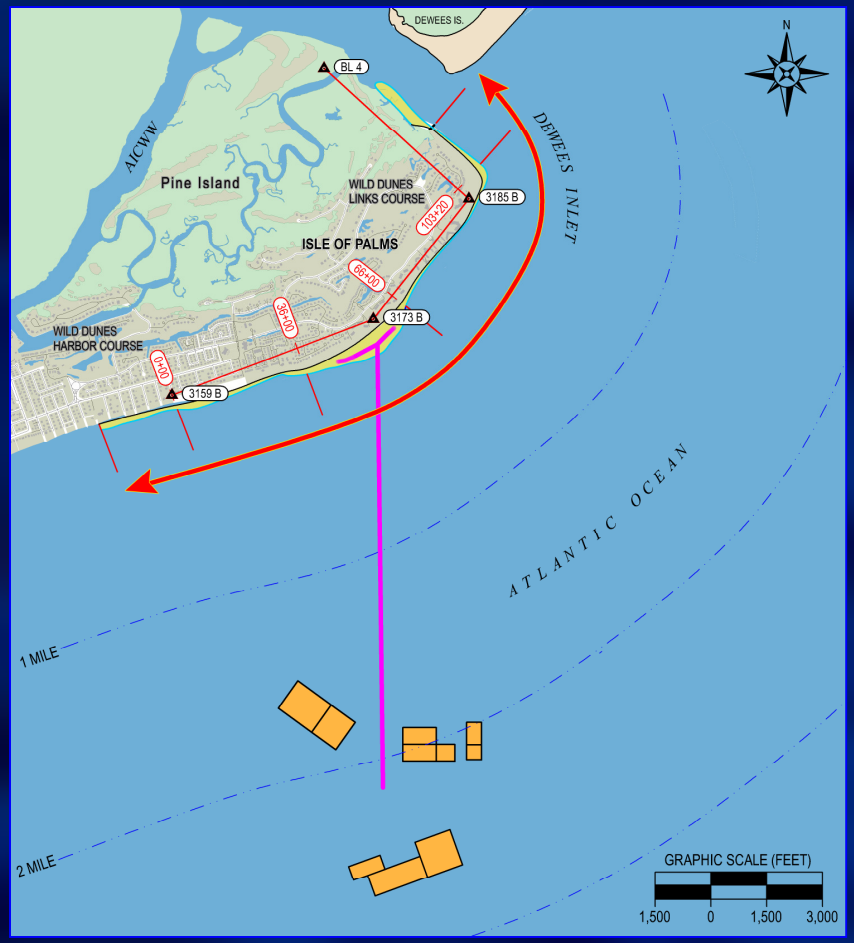
Morphology Maintained Using
A Broad Size Distribution!



Morphology Lost Using Finer Material



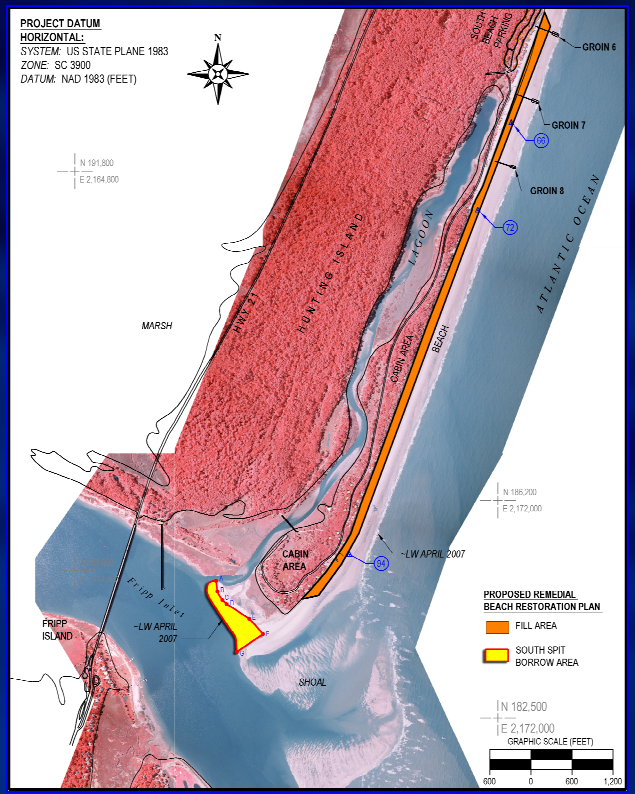
3) Move it the Cheapest Way



Isle of Palms - ~800,000 cy by Hydraulic Dredge @ ~$10/cy*

*including mobilization @ ~$2 million

Hunting Island - ~100,000 cy by offroad trucks @ ~$3/cy



3) Move it the Cheapest Way

Edisto Beach 2006

850,000 cy in ~45 days

Myrtle Beach 1986-87

~850,000 in 8 months over two winters

~60,000 truckloads

4) Cover Your Tracks!

Sand Ramps For Access; Daily Turtle Patrols if in Season

1 Week After Pipe Removal

Elevated Turbidity Should Be Temporary and Confined To The Immediate Discharge Area

Completed Beach Should Look Like A Natural Beach

4) Cover Your Tracks!

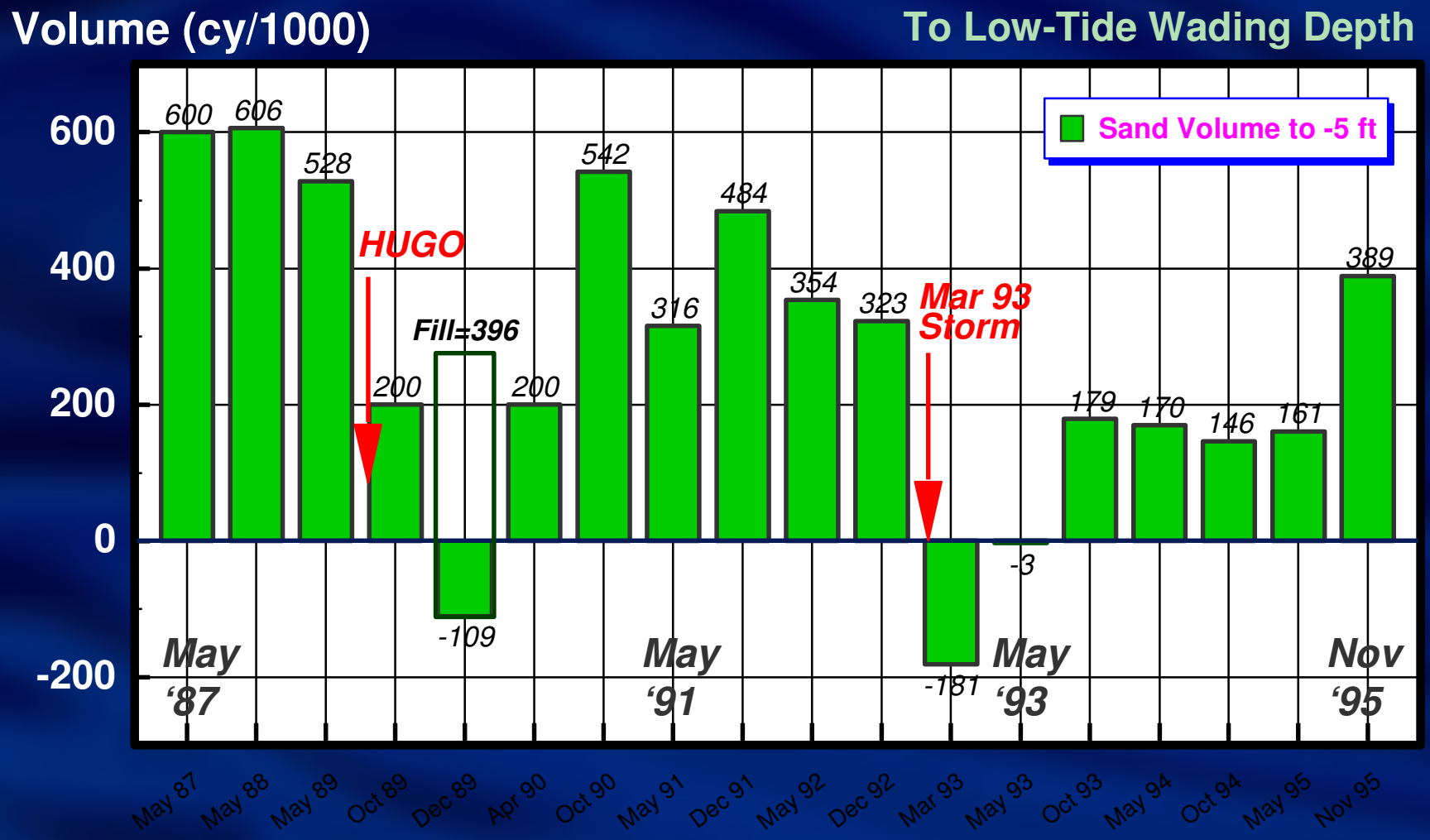
Item 4 of the General Approach Means

Implementing Appropriate
Environmental Protection Measures

5) Monitor Performance

Myrtle Beach

Nourishment Volume Remaining vs March 1985



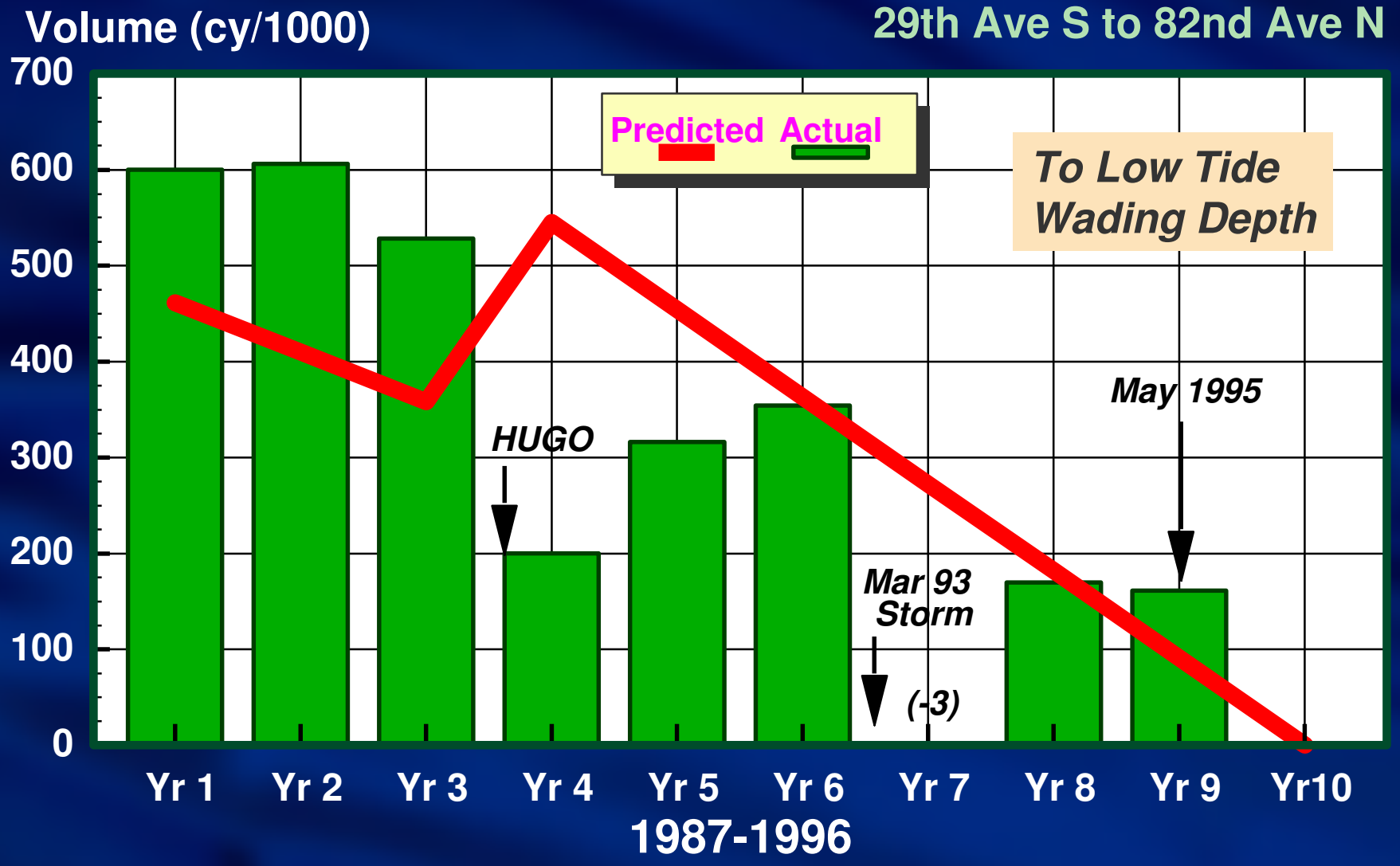
29th Ave S - 82nd Ave N

5) Monitor Performance

"This project won't last 3 years!"
OH Pilkey Jr. 1985

Myrtle Beach - Nourishment Performance

Predicted vs Actual



Innovative Beach Nourishment – Seabrook Island

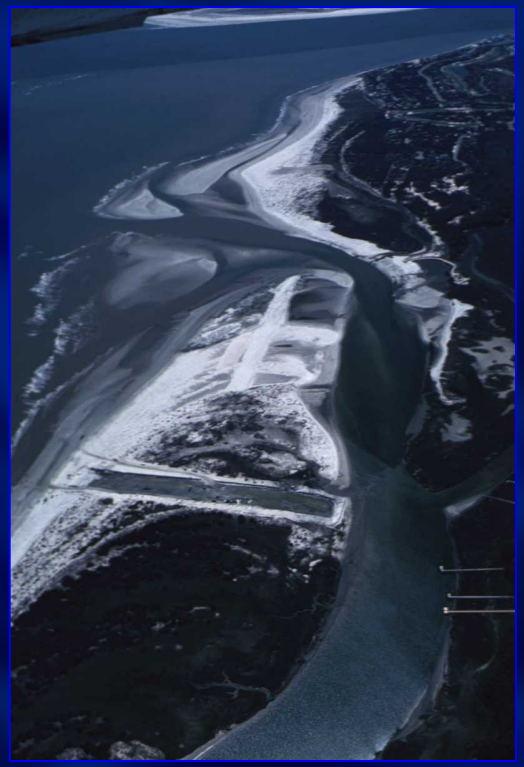
Relocation of Capt Sams Inlet (SC)

- Moved inlet ~1 mile updrift (‘83 & ‘96)
- Added ~2 million CY
- <$500,000 each event

Sep 1983

May 1984

Feb 1986



Mar 1996

Jan 1987

Seabrook Island

Beach Restoration By Inlet Relocation and Nourishment

Successful Nourishment Programs

- ✓Benefits Exceed Costs
- ✓Quality Sand Is Available & Used
- ✓Durable For ~10 years or more w/ minimal maintenance
- ✓Indistinguishable From A Natural Beach
- ✓Provide Demonstrated Reductions In Storm Damage
- ✓Improve Recreation While Protecting Upland Property
- ✓Help Maintain Local Tax Base & Economy
- ✓Maintain Aesthetics of The Coast
- ✓Maintain Habitat & Related Environmental Benefits
- ✓Are Monitored Regularly!
- ✓**Sustained Effort Over Time – Until Such Time As The Economics Do Not Support The Project**

Future Needs & Trends

1) Monitoring and/or Maintenance Nourishment

   - Good Examples: Grand Strand, Folly Beach, Seabrook Island, Hunting Island, Hilton Head

   - Fair Examples: Pawleys Island, Isle of Palms, Edisto Beach

   - Poor Examples: Fripp Island, Harbor Island

   Cornerstone will be Development of Regional Sediment Budgets Incorporating Inlet As Well As Beach Volume Changes

2) Dedicated Funding At Local & State Level – Do Not Count On Fed Funding To Satisfy The Demand

   - Erratic funding impacts dredging costs

   - OCRM should be the arbiter and set priorities for application of limited nourishment funds

3) The condition of SC beaches can be improved beyond the results to date – via targeted nourishment and in some rare cases strategic use of terminal groins

4) SLR is generally of much less concern than site-specific erosion factors